

AMENDMENTS TO THE CLAIMS

Listing of claims:

This listing of claims replaces all prior versions and listings of claims in the application.

Claim 1 (Previously Presented): A spin injection device comprising:

a spin injection part having a spin polarizing part consisting of a ferromagnetic layer and an injection junction part consisting of a nonmagnetic insulating layer; and

SyAF having a first magnetic layer and a second magnetic layer having different magnitudes of magnetization, and magnetically coupled together antiparallel to each other via a nonmagnetic layer, wherein said first magnetic layer of SyAF and said injection junction part are bonded, and

a spin polarization electron is injected from said spin injection part by flowing electric current between said spin polarizing part and said second magnetic layer, wherein magnetization of said first and second magnetic layers is reversed while maintained in antiparallel state without applying an external magnetic field, and wherein

said flowing electric current is 1 mA or less.

Claim 2 (canceled)

Claim 3 (Previously Presented): The spin injection device as set forth in claim 1, wherein said spin polarization electron is capable of spin conservation conduction or tunnel junction at the injection junction part of said spin injection part.

Claim 4 (canceled)

Claim 5 (Previously Presented): The spin injection device as set forth in claim 1 or claim 3, wherein the ferromagnetic layer is provided in contact with an antiferromagnetic layer that fixes the spin of said ferromagnetic layer.

Claim 6 (Currently Amended): The spin injection device as set forth in claim 1 or claim 3, wherein the aspect ratio of the first and the second magnetic layers of SyAF in contact with the injection junction part of said spin injection parts is less than 2.

Claim 7 (Previously Presented): A spin injection magnetic apparatus comprising:
a spin injection part having a spin polarizing part consisting of a first ferromagnetic layer and an injection junction part consisting of a first insulating layer, said first insulating layer formed in contact with said first ferromagnetic layer;
an SyAF free layer formed in contact with said first insulating layer, said SyAF free layer having a first magnetic layer and a second magnetic layer coupled together magnetically antiparallel to each other via a nonmagnetic layer, and in which magnitudes of magnetization are

different, and the magnetization of said first magnetic layer and said second magnetic layer is capable of magnetization reversal while maintaining the antiparallel state; and

a ferromagnetic fixed layer tunnel-junctioned with the first magnetic layer of said SyAF free layer via a second insulating layer, wherein:

said ferromagnetic fixed layer and said free layer are made to be a ferromagnetic spin tunnel junction, and

the magnetization of said first and second magnetic layers is reversed by flowing electric current between said second magnetic layer of the free layer and said ferromagnetic fixed layer while maintained in an antiparallel state without applying an external magnetic field, and wherein said flowing electric current is 1 mA or less.

Claims 8 and 9 (canceled)

Claim 10 (Previously Presented): The spin injection magnetic apparatus as set forth in claim 7, wherein a spin polarization electron is capable of spin conservation conduction or tunnel junction at the injection junction part of said spin injection part.

Claim 11 (canceled)

Claim 12 (Previously Presented): The spin injection magnetic apparatus as set forth in claim 7, wherein the spin polarization part of said spin injection part is provided in contact with an antiferromagnetic layer that fixes the spin of a ferromagnetic layer.

Claim 13 (Previously Presented): The spin injection magnetic apparatus as set forth in claim 7, wherein the aspect ratio of the first and the second magnetic layers of the free layer in contact with the injection junction part of said spin injection part is less than 2.

Claim 14 (Previously Presented): The spin injection magnetic apparatus as set forth in claim 7, wherein said spin injection part is word line.

Claim 15 (Previously Presented): A spin injection device comprising:
a spin injection part having a spin polarization part including a ferromagnetic fixed layer and an injection junction part of a nonmagnetic layer, said nonmagnetic layer formed contacted with said ferromagnetic fixed layer;

a ferromagnetic free layer provided in contact with said injection junction part; and
an antiferromagnetic layer provided on the surface of said ferromagnetic free layer,
wherein:

said nonmagnetic layer of the injection junction part is made of an insulator or a conductor, and

the magnetization of said ferromagnetic free layer by flowing electric current between the spin polarization part and said nonmagnetic layer provided on the surface of said ferromagnetic free layer in the direction perpendicular to the film surface without applying an external magnetic field, and wherein said flowing electric current is 1 mA or less.

Claim 16 (Previously Presented): The spin injection device as set forth in claim 15, wherein said ferromagnetic free layer is made of Co or Co alloy, said antiferromagnetic layer provided on the surface of said ferromagnetic free layer is any one of Ru, Ir and Rh layer, and its film thickness is 0.1 nm - 20 nm.

Claim 17 (Previously Presented): A spin injection device comprising:

a spin injection part having a spin polarization part including a first ferromagnetic fixed layer and an injection junction part of a nonmagnetic layer, said nonmagnetic layer formed in contact with said ferromagnetic fixed layer;

a ferromagnetic free layer provided in contact with said injection junction part; and

a antiferromagnetic layer formed in contact with said ferromagnetic free layer; and

a second ferromagnetic fixed layer provided on the surface of said antiferromagnetic layer, wherein:

said nonmagnetic layer of the injection junction part is made of an insulator or a conductor,

the magnetization of said ferromagnetic free layer is reversed by flowing electric current between the spin polarization part and the second ferromagnetic fixed layer provided on the surface of said ferromagnetic free layer in the direction perpendicular to the film surface without applying external magnetic field, and wherein said flowing electric current is 1 mA or less.

Claim 18 (Previously Presented): The spin injection device as set forth in claim 17, wherein said ferromagnetic free layer and said first and second ferromagnetic layer are made of Co or Co alloy, an antiferromagnetic layer provided on the surface of said ferromagnetic free layer is any one of Ru, Ir and Rh layer, and its film thickness is 2 nm - 20 nm.

Claim 19 (Previously Presented): A spin injection magnetic apparatus wherein, said spin injection apparatus uses the spin injection device as set forth in any one of said claims 15 - 18.

Claim 20 (Previously Presented): A spin injection magnetic memory device, wherein the spin injection magnetic memory device uses the spin injection device as set forth in any one of said claims 15 - 18.

Claims 21-50 (Canceled)

Claim 51 (Previously Presented): A spin injection device comprising:

a spin injection part having a spin polarizing part consisting of a ferromagnetic layer and an injection junction part consisting of a nonmagnetic conductive layer, and SyAF having a first magnetic layer and a second magnetic layer having different magnitudes of magnetization and magnetically coupled together antiparallel to each other via a nonmagnetic layer, wherein said first layer of SyAF and said injection junction part are bonded and

a spin polarization electron is injected from said spin injection part by flowing electric current between said a spin polarizing part and the second magnetic layer, wherein magnetization of said first and second magnetic layers is reversed while maintained in an antiparallel state without applying a external magnetic field, and wherein said flowing electric current is 1mA or less.

Claim 52 (Currently Amended): The spin injection device as set forth in claim [[21]] 51, wherein said spin polarization electron is capable of spin conservation conduction at the injection junction part of said spin injection part.

Claim 53 (Currently Amended): The spin injection device as set forth in claim [[21]] 51 or claim [[22]] 52, wherein the ferromagnetic layer is provided in contact with an antiferromagnetic layer that fixes the spin of a ferromagnetic layer.

Application No.: 10/538,689
Art Unit: 2814

Supplemental Amendment After Final
Attorney Docket No.: 052684

Claim 54 (Currently Amended): The spin injection device as set forth in claim ~~[[21]]~~ 51 or claim ~~[[22]]~~ 52, wherein the aspect ratio of the first and the second magnetic layers of SyAF in contact with the injection junction part of said spin injection parts is less than 2.